Proceedings of the Poughkeepsie Society of Natural Science. Vol. 1, part 1.

Archives of Science and Transactions of the Orleans Co. (Vt.) Society Natural History. Vol. 1.

Bremen Natural Science Society. Vol. 3, part 4; vol. 4, parts 2 and 3, and three quarto pamphlets on Meteorological subjects.

Royal University of Norway. Fourteen pamphlets, 1,000 octavo pages, with many plates.

Topographical Survey of the Adirondacks. One volume, octavo. From Hon. Verplanck Colvin.

Field and Forest. Three volumes, and current numbers to date.

Science Observer. One volume, and parts of current volume to date.

Psyche. Cambridge Entomological Club. Current volume to date.

Vermont Medical Journal. Vol. 1, parts 1 and 2.

Polytechnic Review. Current volume to date.

Introduction and Succession of Vertebrate Life in America, by Prof. Marsh. Pamphlet.

Of the Museum no statements need be made, except that it is poorly displayed for want of space in the Rooms of the State Board of Agriculture, and that a proper expansion and better display of the really valuable geological collection can not be made until after the building of the Capitol extension, when we hope to see it arranged in perfect order and supplemented by collections of the plants, insects and animals of Kansas.

E. A. POPENOE, Secretary.

NOTES ON GIANT'S CAUSEWAY AND FINGAL'S CAVE.

By Prof. C. D. Merrill, Washburn College, Topeka.

In the month of July, in company with an appreciative companion, it was my fortune to be at the little watering place of Portrush, about the middle of the line of the northern coast of Ireland. We took a jaunting car, with a good-natured Irishman as driver, and wheeling rapidly along a very picturesque road that overhangs the sea—the seething bottom of the Devil's Punch Bowl—past rounded hills and splintered cliffs still red with the marks of ancient fire—we came, after traversing eight miles, to that remarkable object of nature, the Giant's Causeway.

This part of the Irish coast is a succession of promontories and recessions, forming vast amphitheatres in the beetling cliffs, that from a height of three hundred feet look down upon the sea. Through one of these amphitheatres we descend to the shore. On the right, vertical in the side of the cliff, stands a group of basalt columns with an exposed front forty feet high, known as the Organ. A little further on at the extreme point of the right promontory are the Chimneys—three tall groups of columns forty-five feet high, and entirely separate from the surrounding rock. On all sides of these amphitheatres, for a distance of six or seven miles along the coast, basalt columns crop out from the cliffs in irregular masses. Standing in this semi-circle, as we turn toward the left the Causeway proper is before us, and unlike most of the great wonders of the world, it breaks upon the view without disappointment. Here is a sharp promontory three hundred feet high, cut down abruptly at the point, nearly to the level of the sea.

This promontory is composed of columns like those of the Causeway, but less perfect and more irregular in arrangement. At the base of this cliff a break in the columns is called the Giant's Gateway. This break forms the base of a triangle whose two sides meet at a distance of one hundred and twenty-five yards at the water level. These lines are the boundaries of the Causeway. As we stand on the base of the triangle then, we are twenty-five feet above the water, and have the whole Causeway before us in one view. Here are more than forty thousand columns of gray basalt standing in such close order that in most cases a knife-blade can not be inserted between them,—all so placed that the general slope from the base of the cliff to the level of the sea is as gradual and smooth as if formed for an actual highway. The length of the whole triangle is, at low tide, 125 yards.

We are told that, in all these forty thousand columns, "there is only one that is triangular—it stands in the east side of the grand Causeway. There are but three columns of nine sides, one in the honeycomb, and the other two near the triangular pillar. The total number of four and eight sides bears but a small proportion to the entire mass of pillars, of which it may be safely computed that ninety-nine out of a hundred have five, six or seven sides." Some are almost perfectly round, in others the angles of the face planes are extremely sharp and clean cut—in fact, most of the columns are beautifully defined in their sides and angles. The diameters of the pillars vary from eight to twenty-two inches—the average is about seventeen. The heads of the columns over which we walk are all either convex or concave. The concavity of a common sized column, eighteen inches in diameter, will hold nearly a pint of water—the cavities are, therefore, shallow. The tops of nearly all the columns are covered with a deposit of slime, which being often wetted by the sea, and dried by the sun, gives a dark and old appearance to the Causeway. This tendency to break in concave and convex forms proves a concretionary structure, and shows that each column is entirely separate from every other.

Dana states that the term basalt was early applied to a group of three rocks, viz: Melaphyre, Doleryte and Peridotyte, belonging to the series Hornblende and Pyroxene. Melaphyre and Peridotyte have nearly the same elements, texture and specific gravity as Doleryte, so we take the composition of the latter as that of the rock composing the Causeway. With a specific gravity of 2.75, there are as elements: Silica, 48.00; Alumina, 16.28; Protoxide of Iron, 15.55; Lime, 9.50; Magnesia, 3.85; Potash, 2.01; Soda, 2.01; Water, a fraction. A more popular analysis would be to say these pillars are composed of about one-half flinty earth, one-quarter iron, and one-quarter clay and lime. In rocks of concretionary structure like basalt, the tendency of the melted material is to concrete about centers. "Basaltic columns, then, are a result of this concretionary structure" (this grouping about centers) "and each column corresponds to a separate action. The size of the columns is determined by the consistency of the mass to be cooled; the thicker the mass, the slower the cooling and the larger the columns. The cracks separating the columns are due to contraction on cooling.

Such is the situation and the mechanical and chemical composition of the Giant's Causeway; but as we stand upon it and contemplate its wonderful formation, the mind is flooded with such questions as these: How far does it extend under the land and how far under the sea? How and when, and under what conditions, did it come into existence, and what is that mysterious power of nature than can thus transform the molten rock into forms of such magnitude and beauty? These and many like questions must remain but partially answered, but until they are answered, the Causeway

will stand an object of the highest interest to the inquiries of the common mind, as well as to those of geological science.

Let us now transfer ourselves for a moment to the island of Staffa, off the middle of the western coast of Scotland. It is eight miles west of the great island of Mull, and about forty from the proper coast of the mainland. Staffa is a mile and a half in circumference, and the surface elevated a hundred feet above the sea, is covered with rich grass that supports thirty cattle for the tenants of the Duke of Argyle. We land from the steamer in small boats, at the eastern side of the island, the only accessible place, and walk over the surface toward the southwest corner. Here we find the highest elevation—144 feet. On the rude wooden stairs built for the purpose, we descend the cliff and reach a range of broken basalt columns, exactly similar to, and hardly less grand than the Causeway of Ireland. Along this range of columns, we proceed 150 yards to the west, and, turning a sharp angle, stand at the entrance of Fingal's Cave. Here, springing out far above us, a stupendous gothic archway supports, at a clear height of seventy feet, an entablature of crushed, prismatic basalt, thirty feet in thickness. The entire front and inner parts of the cave are composed of range on range of magnificent columns, with beautiful joints and wondeful symmetry of form. The length of the cave within is 230 feet, the roof is of solid masses of basalt, the sides of huge pillars in their usual forms, the pavement of water in ceaseless motion.

The question now arises, what connection, if any, there is between these two similar geological formations, the Causeway and the Cave. One is on the north coast of Ireland, and sloping gently under the sea, points its main ridge northward, exactly toward the Island of Staffa. The other, off the west coast of Scotland, a hundred miles away, also slopes gently under the sea, sending its main ridge southward toward the Irish Causeway. Looking at the mountain lines of Great Britain and Ireland, we find their general trend is north and south. We find also that the rocky ridge forming Argyleshire—being interrupted by only sixteen miles of shallow water between the Mull of Cantire and the Irish coast—is continued southward by the mountains of Eastern Ireland. These basalt formations, then, are found in the slopes of a great mountain valley. We find conditions similar to these in the Valleys of Connecticut, of New South Wales, and of the Hudson river, and these places are famous for their dikes, ridges of basalt columns and trap rock formations. If, then, dikes are formed under such conditions, it seems fair to connect the formation of the Cave and the Causeway as two visible portions of a vast dike, whose hidden parts are under the land and the sea. The general statement, then, will be this. At a former period a fissure was opened by subterranean force along this mountain valley, extending itself from Staffa to the Irish coast. From this fissure vast quantities of molten rock poured upward, and, on reaching the surface, crystalized into its natural forms. That there are many oblique and horzontal columns may be explained by the natural action in the dike—the top of the molten mass, crystalizing into columns first, was pushed out and over by the liquid mass rising from below. Probably the phenomena of the origin of any small dike may apply to the origin of this greater one—it may be the very magnitude of the formation that deceives the investigator of its origin.

I give here the most common of the many legends among the Irish, accounting for the formation of the Giant's Causeway: The giant, Fin McCoul, was the champion of Ireland, and was angry at the boasting of a certain Scotch giant, who offered to give the Irish champion a beating, provided he could cross over to Ireland without getting wet. Thereupon Fin McCoul obtained permission of the king, and biult a causeway straight over

to the dwelling-place of the Scot. Upon this causeway the Scot crossed over to Ireland, and was badly beaten by Fin McCoul, who then generously invited the Scot to continue in Ireland. The invitation was accepted, for everybody knows that Scotland has ever been a hard place to get a living in, while Ireland was always the richest country in the world. May not this legend point to the former existence of the whole as parts of a causeway between Staffa and Ireland? It certainly indicates an old belief of the people in the existence of such a causeway.

I conclude these notes with one more thought on the formation of Fingal's Cave—a thought that occurred to me when surveying the ecclesiastical ruins of Iona, a thought of which I can not say whether it is original because peculiar, or peculiar because iriginal. The Island of Iona, nine miles southwest of Staffa, was one of the first seats of Christianity in Britain. St. Colomba, an Irish missionary, began religious foundations there in the fourth century. He was one of the Culdees, who preferred lonely and retired places. In this island are many fine old ruins of a cathedral, a chapel and nunnery, and some peculiar carved pillars called the Iona crosses. Of these crosses there were in the island, previous to the Reformation, about 360, marking the graves of kings, abbots and monks. These crosses semed to be as basalt, like the pillars of Fingal's Cave. Now while in Fingal's Cave, I was wondering how it was possible that the sides of the cave, as they are at present, could have ben formed by the forces of nature alone. For the pilars along the sides are broken out to the width of five or six feet, leaving their broken ends adhering to the crushed basalt of the roof, while the lower ends form a pathway by which one may traverse the length of the cave as in a side gallery of a church. It seems impossible that these columns should be thus broken by nature, and so when I saw the crosses on the adjacent island, the thought came at once, that they were the missing pillars of Fingal's Cave. Is it not possible that these hardy Christians pried out, as would be comparatively easy, the pillars along the sides of the cave, and made them into the crosses that once marked the graves of their dead? The number of broken columns in the cave I judged to be about equal to the number of the crosses—three hundred and sixty. Perhaps, then, the cave as it now stands is partially the work of man.

Possibly, too, it was used as a place of retreat or worship by the Culdees before they built their cathedral in Iona. It would certainly be a beautiful thought to the Christian mind, that the earliest songs and prayers of his faith went up to the Creator from this temple of His creation, which seems to me nobler than any yet raised by human hands.

I remember that just as we were entering the cave, fifty tourists in the farther end took up together the strains of the "Old Hundredth" hymn: and as the full notes went up along the great shadowy vault, and rolled back and forth multiplied into a sounding flood of music, it seemed to me that I had never heard a hymn of praise in so appropriate a place.

Then followed the strains of "God Save the Queen," so grateful to American ears as our national hymn. And there, as it were, in the very bosom of the earth, with the prismatic tints of blue and green and gold in the vault above answering back the beams of rising light reflecting from the waves below, with the boom of the sea, as it rolled its long surges up the watery aisles and hurled them thundering against the opposing wall, closed in about on every hand by the pillared forms of everlasting rock—what a place it was for the inculcations of loyalty to God and native land—what a place it was in which to read the story of the creation.